SDN

"Roadmap to Operating SDN-based Networks" Workshop

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Agenda

- Three aspects of SDN
- SDN @ Juniper
- OpenContrail
- NorthStar

Three aspects of SDN

- Programmability
- Automation
- Abstraction (SDN as a Compiler)

Programmability

- Your software vendor gives you a nice OS and some nice apps
  - But these don't do all you need
- You want to improve performance or scale
  - Or you want to add a new feature
  - Or you just want to play
- Usually, the vendor gives you an API
  - The rest is up to you ☺

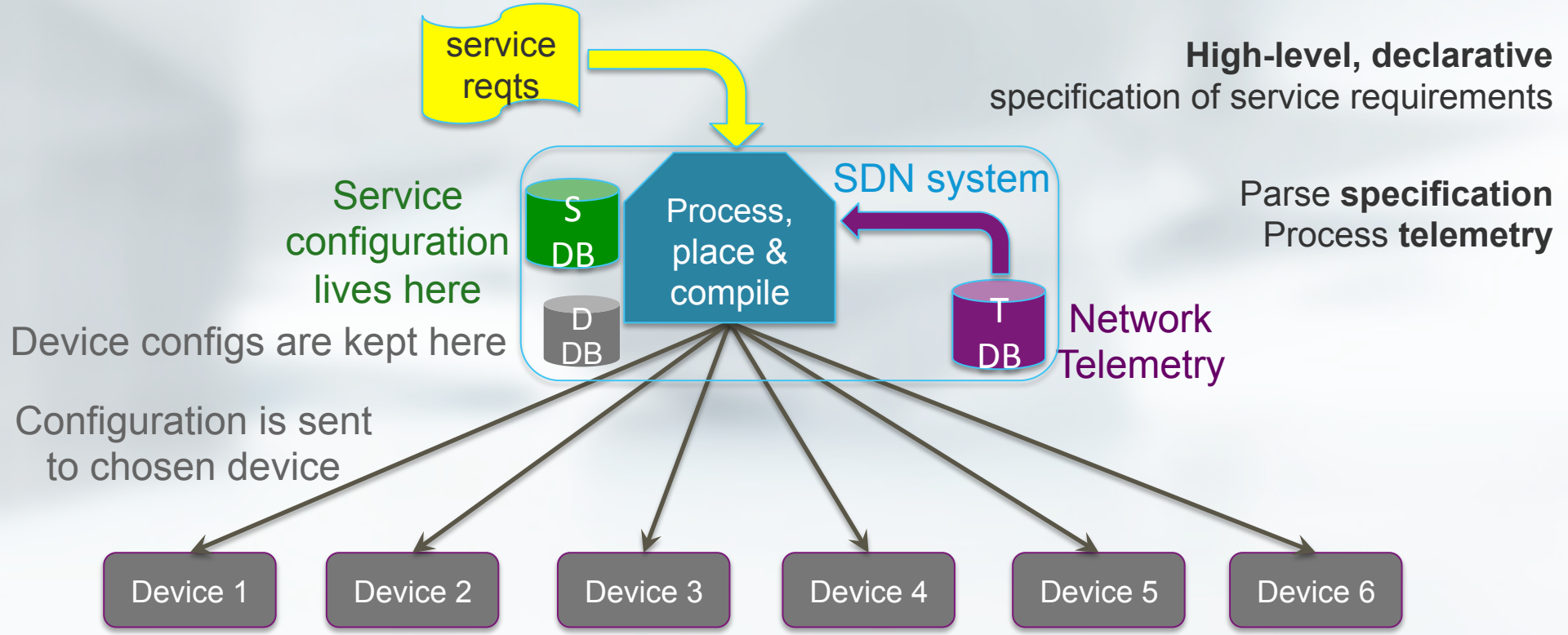
Automation

- You know what you want to do
  - You do it manually for a device or two
- Now, you want to do it for 100s or 10s of 1000s of devices
  - You need to parametrize what you did at a small scale
  - You need mechanisms whereby devices can ask for help, or send telemetry to your Automation Agent
  - You need rules (“policy”) to handle exceptions or to adapt to situations
- The vendor gives you a framework, tools, mechanisms to enable and/or simplify your task
  - Again, the rest is up to you ☺

Abstraction

- You have a nice language: high-level, abstract, device-independent
  - Programming languages are primarily imperative (C, Java, Python)
  - But many are declarative (LISP, SNOBOL, Haskell, …)
- You define what you want to have happen
  - Imperative: state how you want things done
  - Declarative: state what you want done
- The language compiler translates this to a lower-level language that your devices can understand and carry out

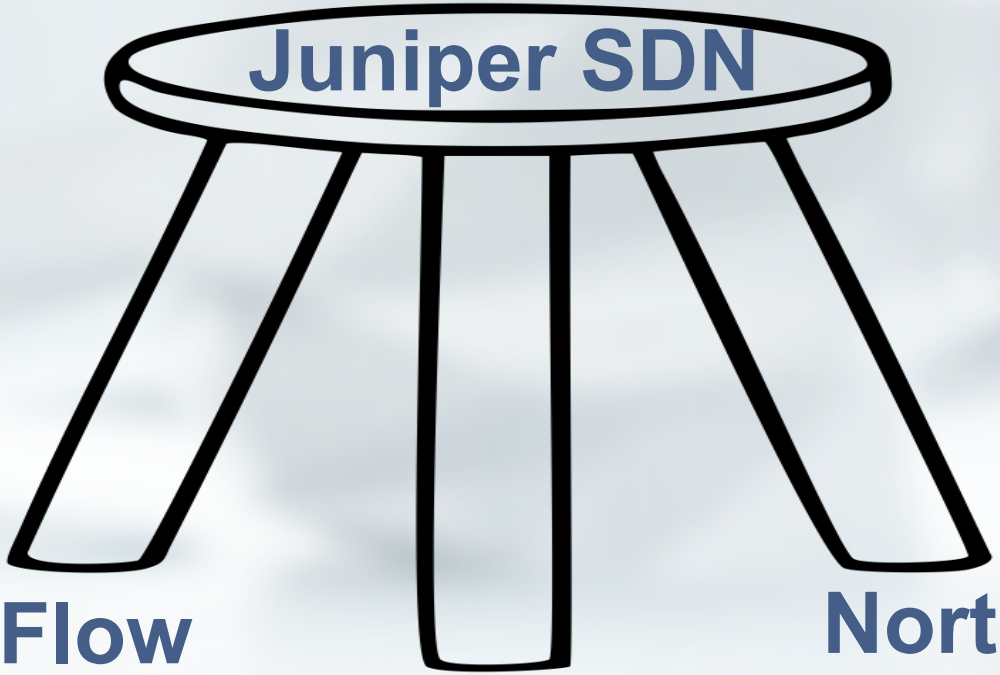
SDN as a Compiler
Say *what* you want, not *how* to do it



SDN @ Juniper

- OpenFlow
- OpenContrail
- NorthStar

SDN @ Juniper



OpenFlow
Supported Protocol

OpenContrail
Datacenter SDN Product

Northstar
WAN SDN Product

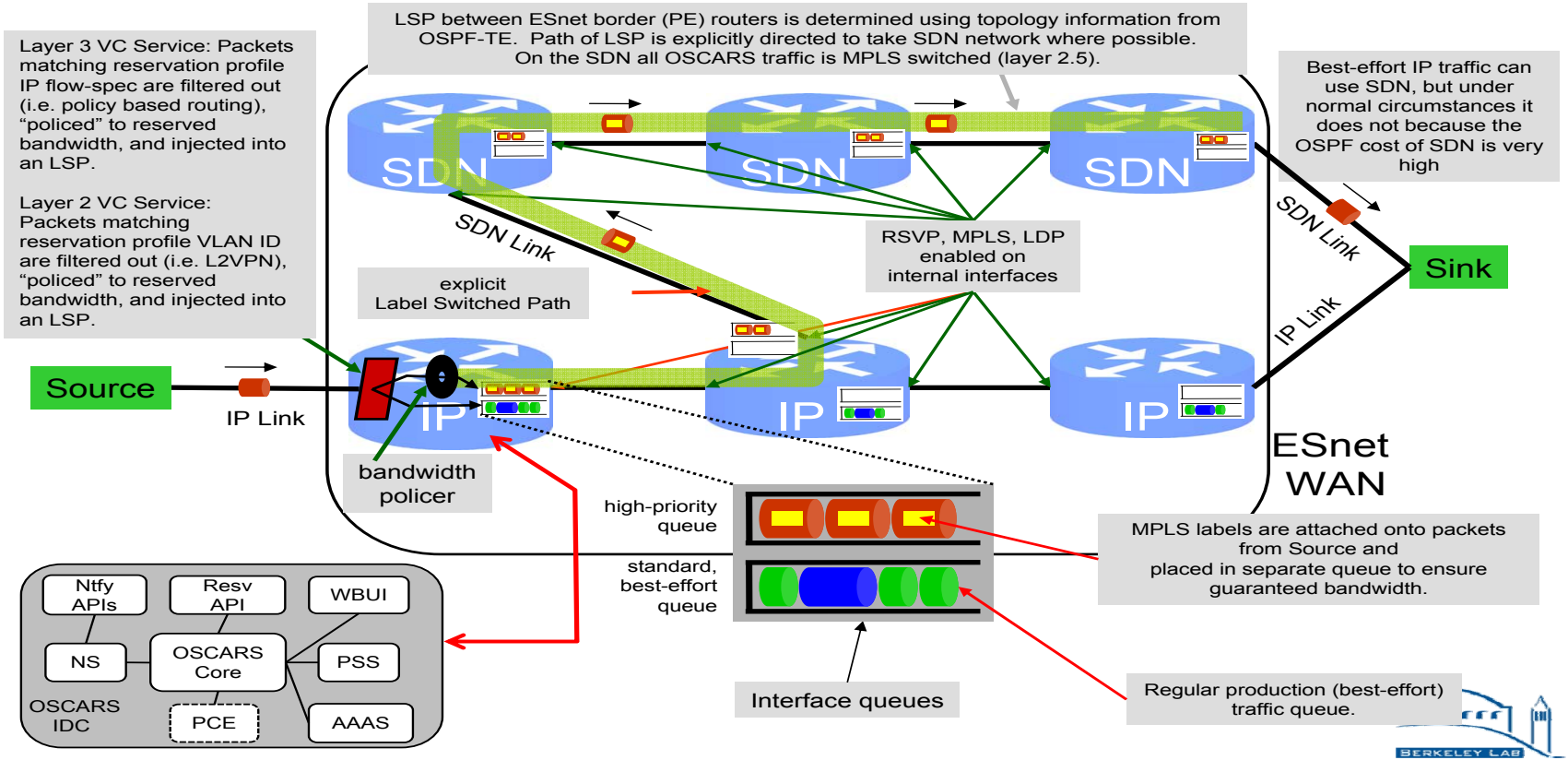
OpenFlow

- Juniper supports OpenFlow 1.0 and 1.3 on its MX routers, EX and QFX switches
- More info at:

http://www.juniper.net/documentation/en_US/release-independent/junos/topics/reference/general/junos-sdn-openflow-supported-platforms.html

- OpenFlow != SDN
- A good example of SDN that this audience will be familiar with is OSCARS.

Network Mechanisms Underlying OSCARS



Juniper's SDN Strategy

DC

- Virtualization / Services
- Data centers
- Contrail

SDN STRATEGY

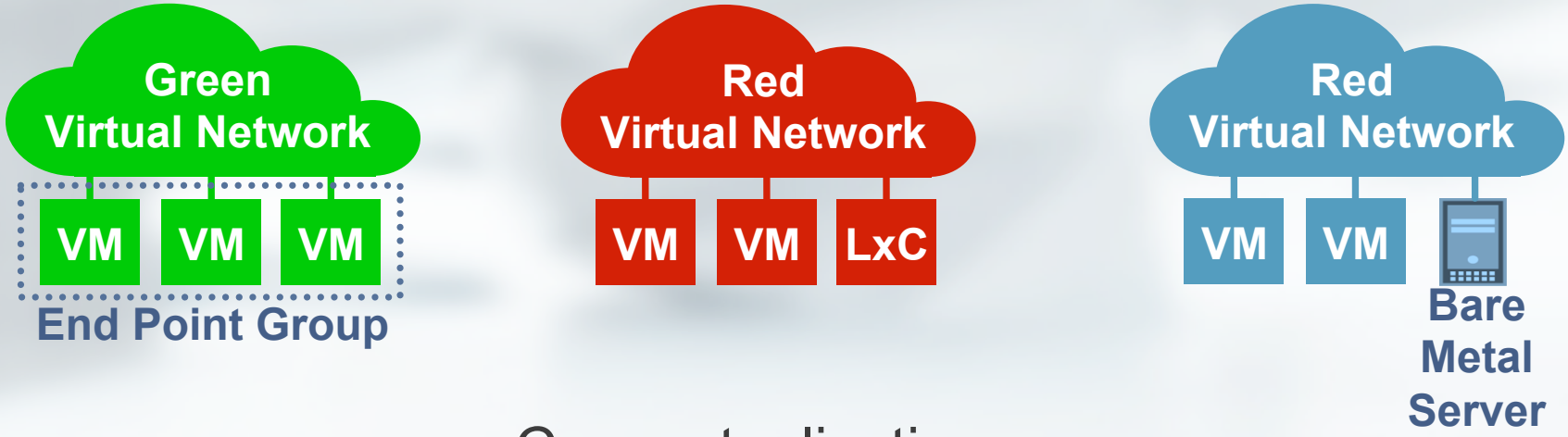
SP

- Network Optimization
- Wide Area Networks
- NorthStar

OpenContrail: Network Virtualization for multi-tenant DCs

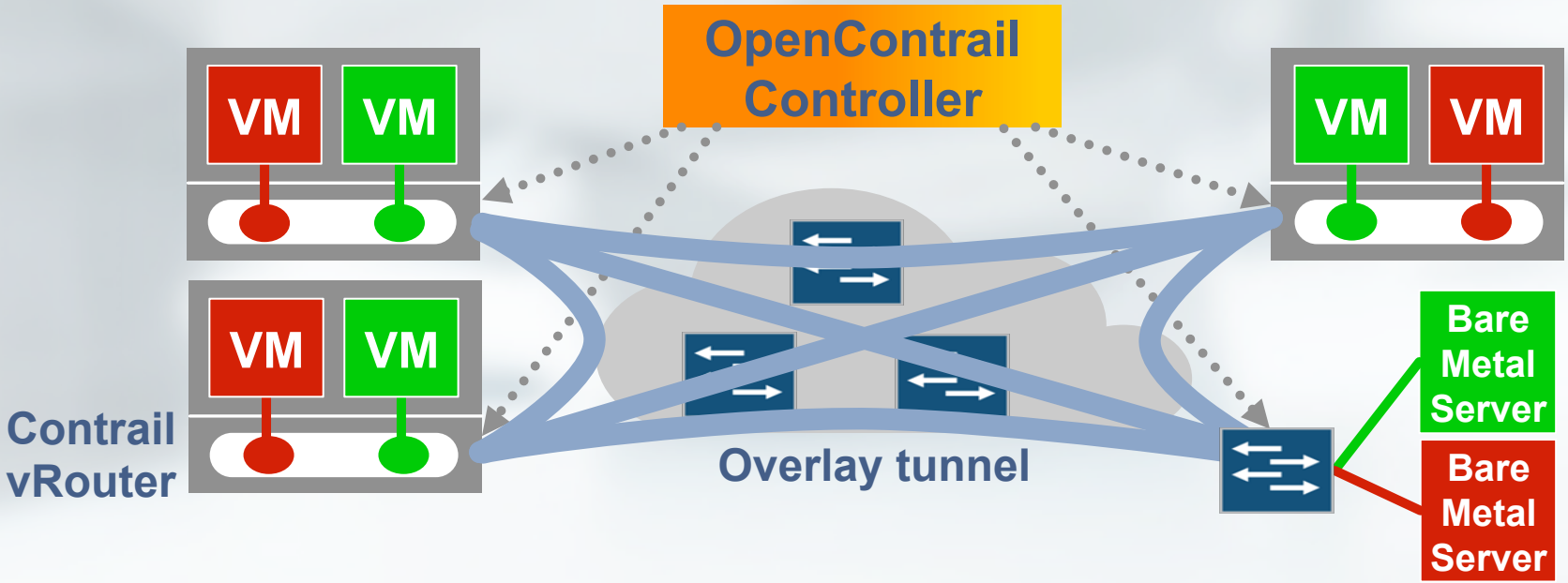
A Case Study in Abstraction

Network Virtualization in the Data Center



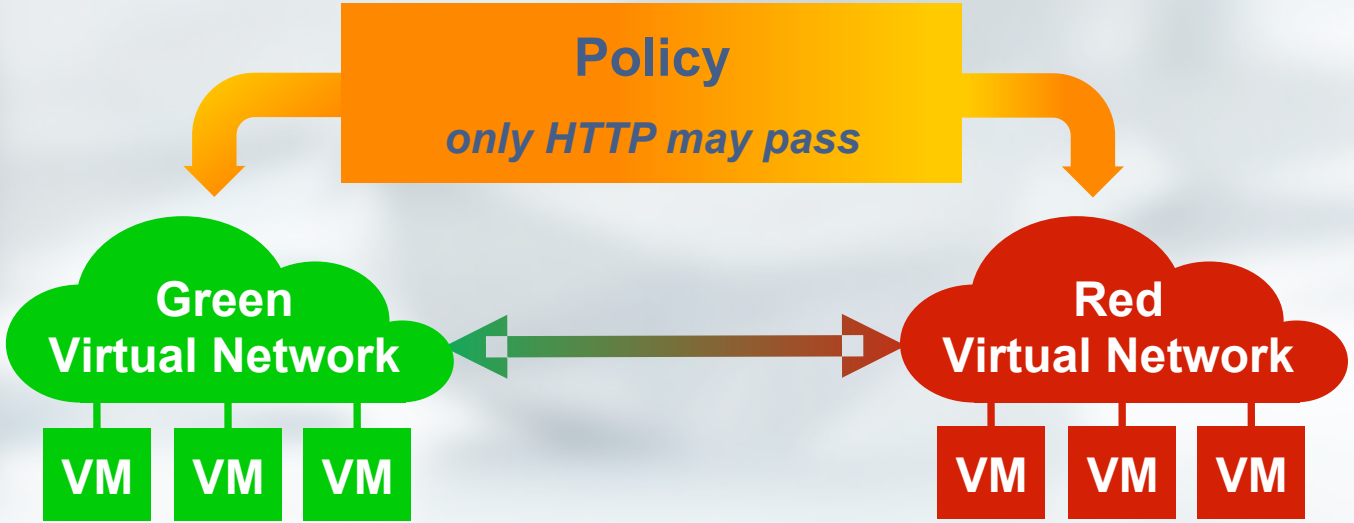
Conceptualization
(Abstraction)

OpenContrail Network Virtualization

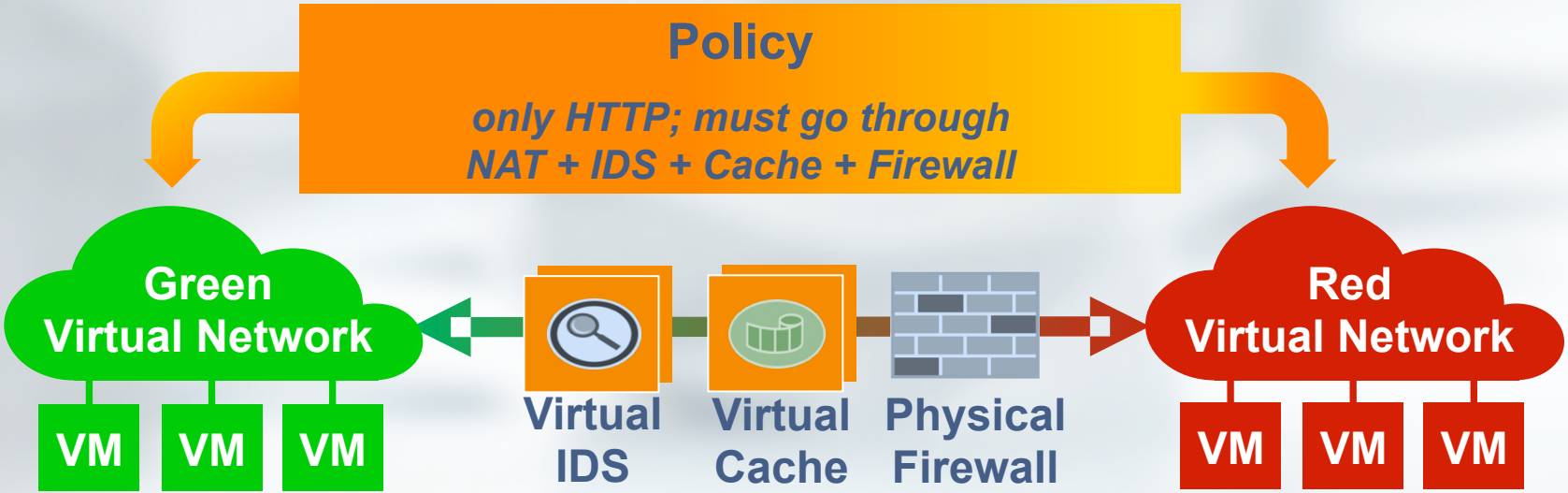


Underlying these abstractions: BGP MPLS VPNs signaled over xmpp running over MPLS/GRE, MPLS/UDP or VXLAN

Group Based Policies



Service Chaining (with VNFs and PNFs)



All of the above (and more) has been implemented and deployed

Juniper NorthStar TE Controller

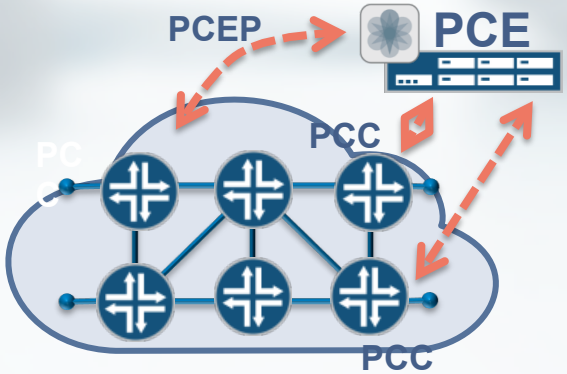
Centralizing *Some* Control Plane Functions

PCE ARCHITECTURE

A Standards-based Approach for Carrier SDN

What is it?

A path Computation Element (PCE) is a system component, application, or network node that is capable of determining and finding a suitable route for conveying data between a source and a destination



What are the components?

- **Path Computation Element (PCE):** Computes the path
- **Path computation Client (PCC):** Receives the path and applies it in the network. Paths are still signaled with RSVP-TE.
- **PCE protocol (PCEP):** Protocol for PCE/PCC communication

PCE: EVOLUTIONARY APPROACH

Active Stateful PCE Extensions

REAL-TIME AWARENESS OF LSP & NETWORK STATE	▪ PCE dynamically learns the network topology ▪ PCCs report the LSP state to the PCE
LSP ATTRIBUTE UPDATES	▪ Via the PCEP, the PCE can update LSP B/W & path attributes, if the LSP is *controlled*
CREATE & TEAR-DOWN LSPS	▪ The PCE can *create* LSPs on the PCC, ephemerally
HARDER PROBLEMS OFFLOADED FROM NETWORK ELEMENT	▪ P2MP LSP path computation & P2MP tree diversity ▪ Disjoint SRC/DST LSP path diversity ▪ Multi-layer & multiple constraints

* No persistent configuration is present on the PCC

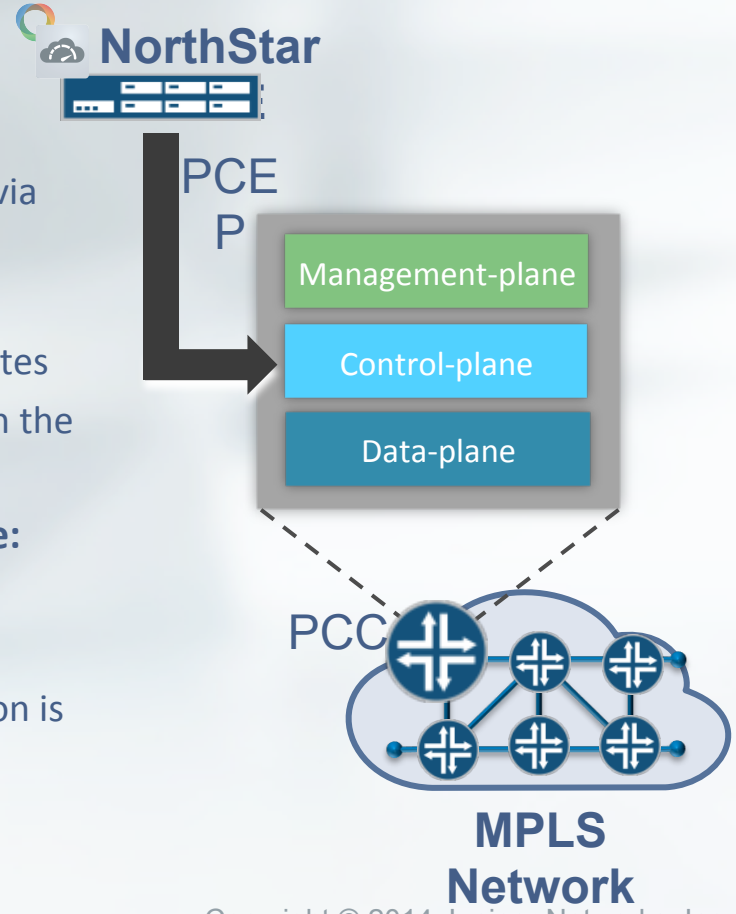
WHAT DOES THAT REALLY MEAN?

Why is it an active Stateful PCE:

- Northstar-PCE is synchronized, in real-time, with the network via standard IP networking protocols; OSPFv2, ISIS, BGP-LS, PCEP
- Northstar-PCE has visibility of the available RSVP B/W
- Northstar-PCE has visibility into the LSP state; RRO, LSP attributes
- Northstar-PCE can have ‘control’ of LSPs & create ‘state’ within the MPLS network

Northstar is an extension of the MPLS (routing) control-plane:

- A PCE is only concerned with the transport LSPs of an IP/MPLS network (MPLS = RSVP-TE)
- While Northstar-PCE can *create* an LSP via PCEP, that creation is NOT configuration in the management-plane of a PCC

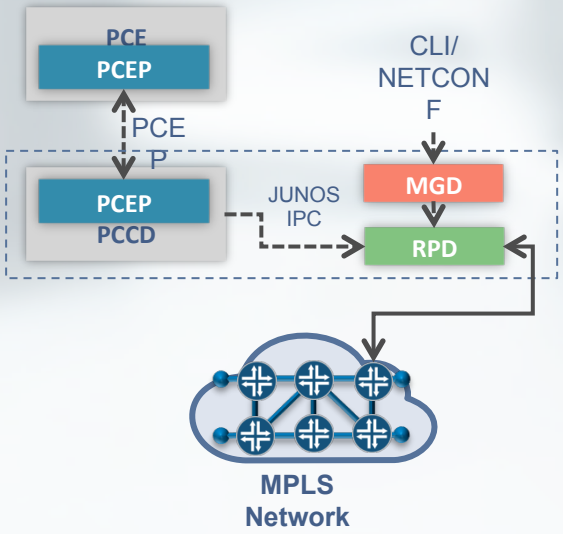


THE CLIENT (PCC) IS IMPORTANT - JUNOS PCEP SUPPORT

New JUNOS daemon, pccd

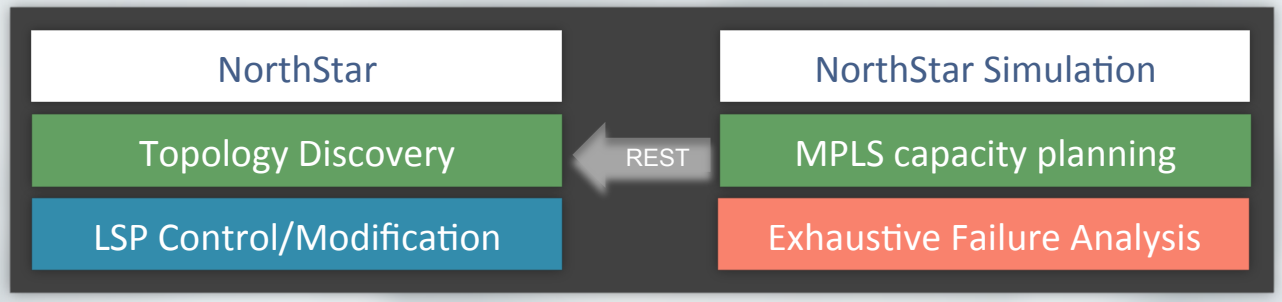
PCCD enables a PCE application to set/modify/get parameters for a traditionally configured TE LSPs and for ephemerally created LSPs

- PCCD is the PCC instantiation of PCEP
- As PCEP evolves, PCCD MUST be enhanced/upgraded



ACTIVE CONTROL VS. OFFLINE PLANNING

NorthStar-PCE vs. Northstar-Simulation



REAL-TIME NETWORK FUNCTIONS

- Dynamic Topology updates via BGP-LS / IGP-TE
- Dynamic LSP state updates via PCEP
- Real-time modification of LSP attributes via PCEP (ERO, B/W, pre-emption, …)

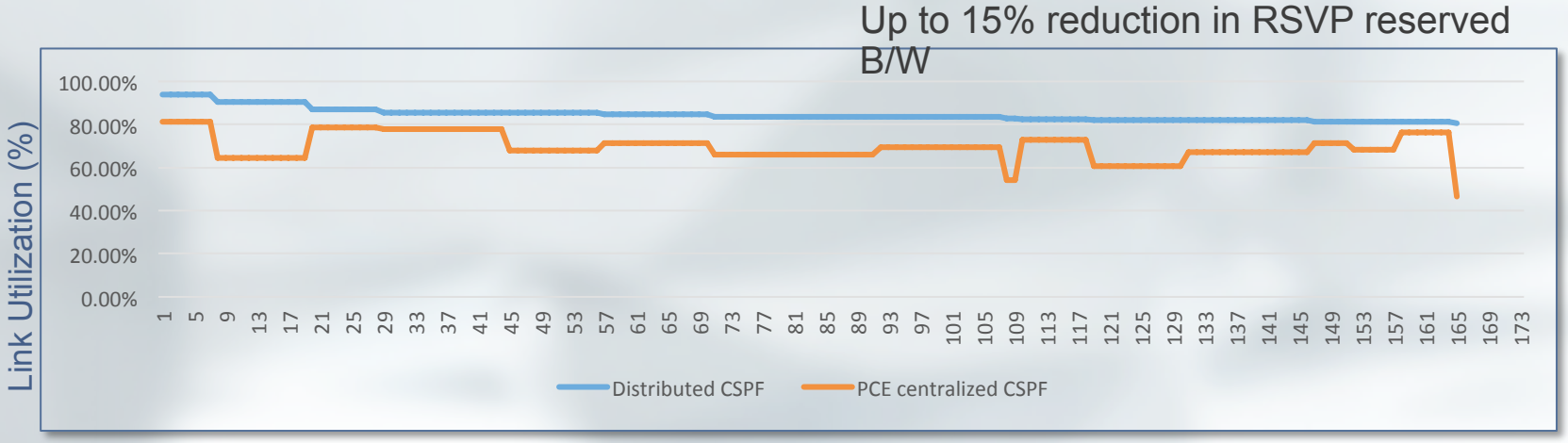
MPLS LSP PLANNING & DESIGN

- Topology acquisition via REST API
- LSP provisioning via REST API
- Exhaustive failure analysis & capacity planning for MPLS LSPs
- MPLS LSP design (P2MP, FRR, JUNOS config'let, …)

A CUSTOMER EXAMPLE – PCE RESOURCE OPTIMIZATION

Centralized vs. distributed path computation

Up to 15% reduction in RSVP reserved B/W



Distributed CSPF Assumptions

- TE-LSP operational routes are used for distributed CSPF
- RSVP-TE Max Reservable BW set BW set to 92%
- Modeling was performed with the exact operation LSP paths

Centralized Calculation Assumptions

- Convert all TE-LSPS to EROs via PCE design action
- Objective function is Min Max link utilizations
- Only Primary EROS & Online Bypass LSPS
- Modeling was performed with 100% of TE LSPS being computed by PCE

ADDITIONAL INFORMATION

opencontrail.org

- Open source + documentation + IETF drafts + blogs + Q&A and more

Northstar:

- http://www.juniper.net/us/en/products-services/sdn/northstar-network-controller/

PCEP:

- http://tools.ietf.org/html/draft-ietf-pce-stateful-pce-07
- https://tools.ietf.org/html/draft-crabbe-pce-pce-initiated-lsp-03
- http://tools.ietf.org/html/draft-ananthakrishnan-pce-stateful-path-protection-00
- http://tools.ietf.org/html/draft-minei-pce-association-group-00
- RFC 5440: Path Computation Element (PCE) Communication Protocol (PCEP)
- RFC 7190: Conveying Vendor-Specific Constraints in the Path Computation Element Communication Protocol

BGP-LS:

- http://www.ietf.org/id/draft-ietf-idr-ls-distribution-05.txt

Postscript: OpenConfig

- OpenConfig is a provider-driven effort to standardize configuration
- Participants are Web2.0 companies, Tier 1 and Tier 2 SPs
- Initial target is BGP + routing policy, IGP and MPLS config
- Next up are services
- All these are expressed in the YANG data modeling language
- Juniper has alpha code implementing OpenConfig models
  - An official release is slated for 2016

Feel free to consider this as SDN :)

Thank You!